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APPLICATION BULLETIN

SR633 & SR634 Coagents For Rubber To Metal Adhesion Without Adhesives

Introduction

SR633 and **SR634** are coagents for peroxide-cured elastomers that produce:

- Extremely strong rubber-to-metal adhesion without the use of external adhesives
- Improved rubber mechanical properties

Conventional metal reinforced rubber products require both an adhesive to bond the metal to the rubber and a separate curing system to increase the mechanical properties of the rubber, as shown in Figure 1.

In contrast, the **SR633** and **SR633** coagents develop adhesive bonds at the metal-rubber interface during the curing step, while at the same time produce crosslinks in the rubber as illustrated in Figure 2.

Coagents

SR633 is anhydrous zinc diacrylate containing a non-nitroso scorch retarder. **SR634** is anhydrous zinc dimethacrylate containing a non-nitroso scorch retarder.

Characterisitics

- Free flowing, 100% reactive solids
- Easily dispersed
- Non-volatile
- Low odor
- Provide scorch protection with non-nitroso retarder
- Improve properties through ionic bonding EPDM to steel and brass.

Figure 1

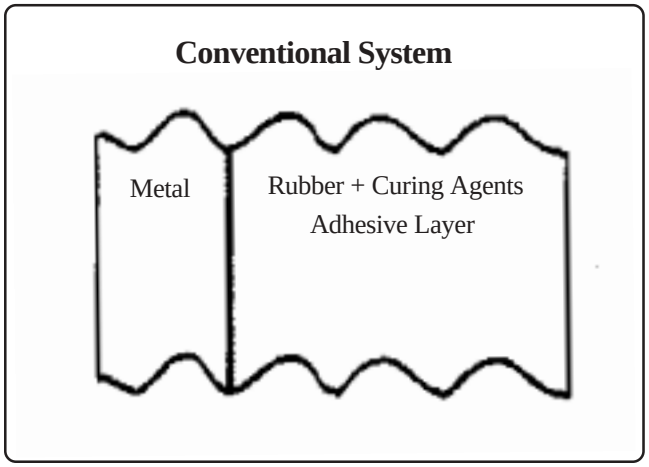
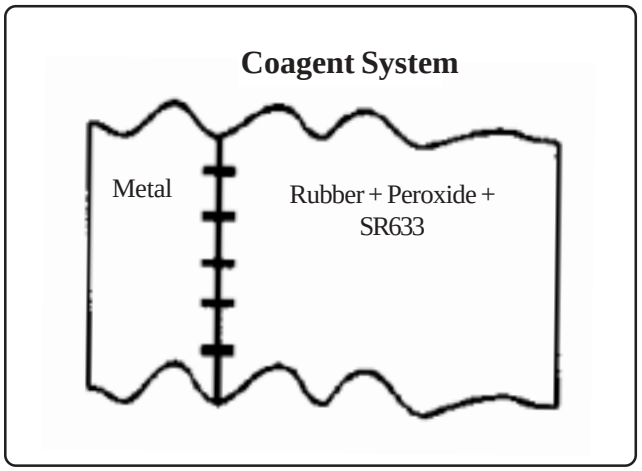


Figure 2



Adhesion

The lap shear adhesion data in Figure 3 shows the superiority of the **SR633** coagent system over conventional solvent based adhesives for bonding EPDM to steel and brass.

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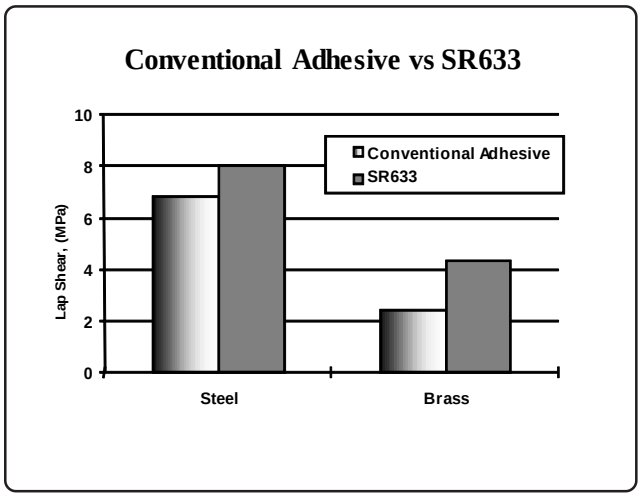
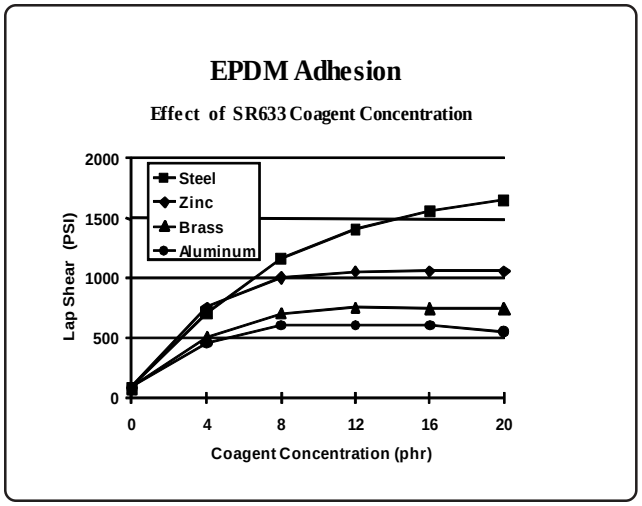
Figure 3



The **SR633** system also promotes good adhesion to other metals including aluminum, zinc, and stainless steel, as shown in Figure 4. Adhesion increases rapidly as the **SR633** concentration increases. This means strong adhesive bonds can be created economically with low coagent levels.

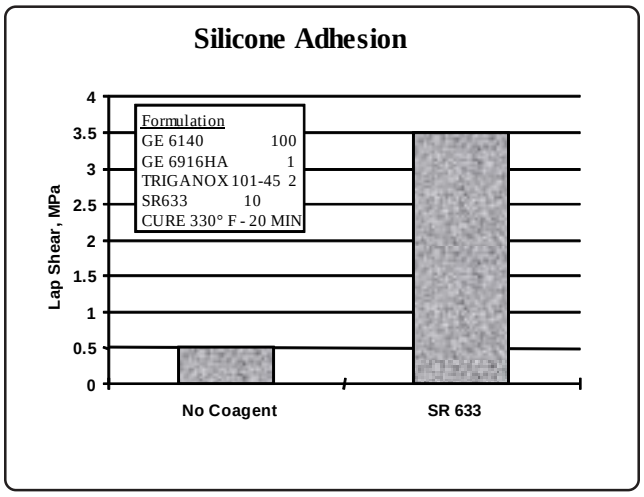
Figure 4



Silicone Adhesion

Strong rubber to metal bonding can be obtained with a variety of elastomers, such as NBR, HNBR, neoprene, SBR and silicone. Silicone adhesion is illustrated in Figure 5.

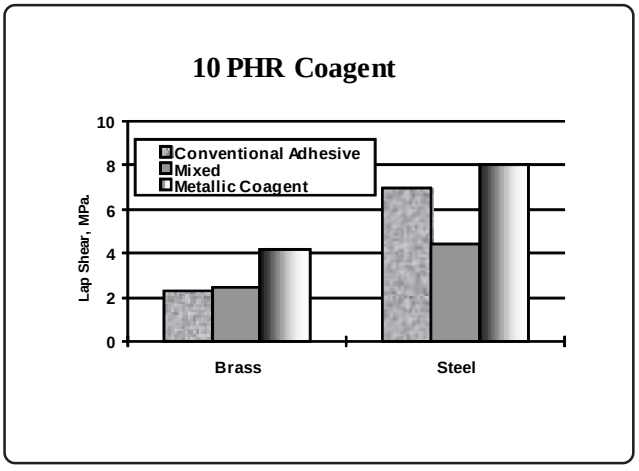
Figure 5



Mixed Adhesive Systems

The use of a conventional adhesive in combination with the **SR633** is not necessary. The conventional adhesive usually exhibits a lower lap shear strength than the **SR633** resulting in a weakening of the **SR633** system, as shown in Figure 6.

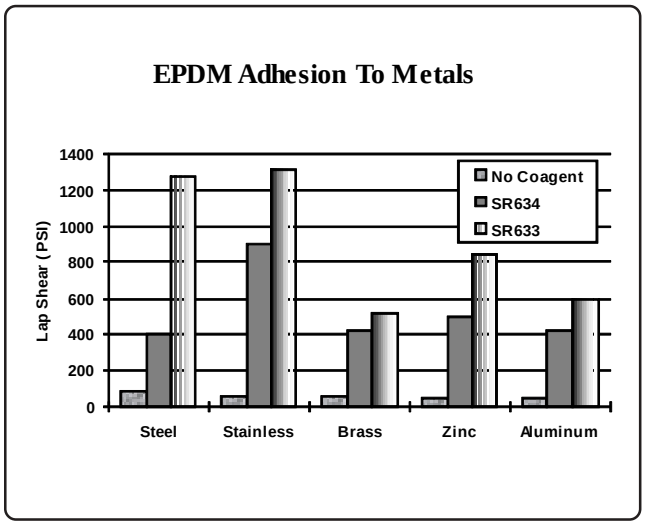
Figure 6



Alternate Coagent

SR634, while not as effective as **SR633**, also increases rubber to metal adhesion in peroxide-cured elastomers. In applications where high tear strength, abrasion resistance and water resistance are needed, the **SR634** coagent can be used. Mechanical properties of the rubber cured with the **SR634** are excellent. Figure 7 compares **SR633** and **SR634** adhesive properties for EPDM.

Figure 7



Aged **SR633** rubber-to-metal adhesive bond remains strong even when exposed to heat and moisture. Table 1 shows no deterioration in lap shear strength under heat aging at 300°F and submersion under water at room temperature for 165 hours.

Table 1
Aged Lap Shear Adhesion, MPa
EPDM To Cold Rolled Steel
10 PHR **SR633**

Unaged Control		8.0
Heat Age 300°F		
	96 HR	8.3
	165HR	8.5
Water Submersion, 70°F		
	66 HR	8.6
	165HR	7.9

Rubber Mechanical Properties

The mechanical properties of rubber cured with **SR633** and **SR634** are superior to those obtained with conventional coagent systems. The **SR634** is noted for its elongation and tear strength while **SR633** gives excellent tensile strength and modulus as shown in Table 2.

Table 2

Physical Property Comparison in EDPM

Nordel 1040 (1)	100	100	100
N762 Black(2)	100	100	100
Sunpar 2280 (3)	50	50	50
Zinc Oxide	5	5	5
Stearic Acid	1	1	1
Agerite Resin (4)	1	1	1
Dicup 40 KE (5)	7.5	7.5	7. 5
TMPTA	10	-	-
SR633	-	10	-
SR634	-	-	10
Scorch TS_2, Min	1.4	1.7	1.4
TC(90) Min	6.4	6.8	10.4
Tensile, PSI	1000	1240	1190
Elongation, %	680	710	820
$Modulus_{100}$, PSI	140	180	150
Shore A Hardness	56	57	56

(1) Dupont EPDM
(2) SRF, Furnace Black
(3) Sun Oil Company, Plasticizer
(4) Monsanto Company, Antioxidant
(5) Hercules, Inc., Dicumyl Peroxide

Advantages of the Metallic coagent

- Gives stronger rubber-to-metal bonds than conventional adhesives.
- Applicable to most rubber and metals
- No adhesive to dry.
- No solvent vapors to vent.
- No waste adhesive to discard.
- Gives superior mechanical and heat age properties.
- Provides scorch safety.

Note: Mold release agents should be used if cure mold contacts rubber surface.

Compounding & Curing

The **SR633** and **SR634** coagents can be **SR633** mixed with most rubbers using a two roll mill or a Banbury internal mixer. Curing the resulting rubber compound against the metal substrate creates the adhesive bond as well as the mechanical properties of the rubber. For example, the EPDM formulations described in Table II were mixed on a two roll mill and sheeted out to a thickness of 0.03 inches. Strips of the rubber sheeting were then placed between the appropriate metal panels and cured in a compression mold for 20 minutes at 330°F. The shear adhesion values and the mechanical properties reported in this bulletin were determined according to ASTM test methods D816-55 and D412-80, respectively.

Handling And Storage

Metallic coagents demonstrate a low order of toxicity. Handle in accordance with good industrial hygiene practice which includes minimizing exposure of coagent to the eyes, skin, and clothing. Refer to the Material Safety Data Sheet for complete information on toxicity and recommended handling procedures.

Store in a cool and preferabley air-conditioned area where the ambient temperature does not exceed 80°F. Keep containers tightly closed util ready to use so as to avoid loss of activity. The coagents are anhydrous to a humid atmosphere. For optimum results, use within 6 months of receipt.